Uptake and accumulation of car tire rubber-related organic chemicals in blue mussels *(Mytilus edulis)*

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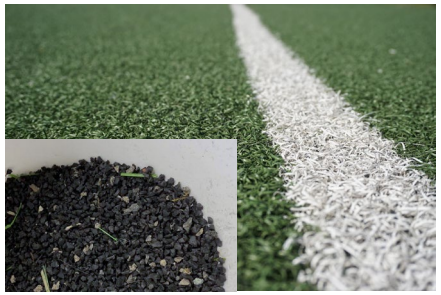
ANDROMEDA

Car tire rubber particles (CTRPs)

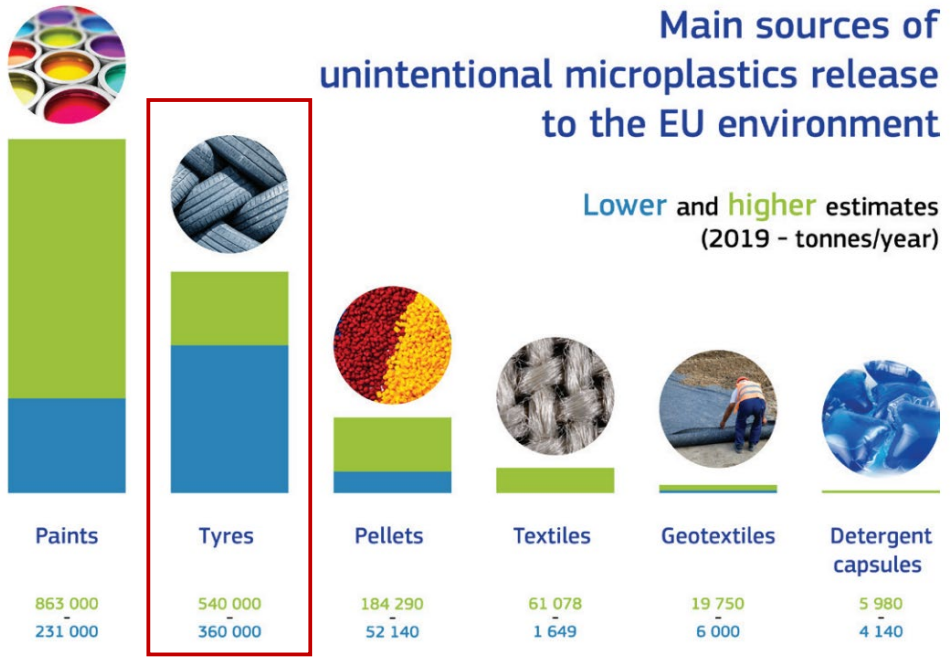


Sources

- Abrasion from driving → Tire wear particles (TWPs)
- Usage of end of life tires → Crumb rubber (CR)

One of the largest contributors to world wide microplastic pollution

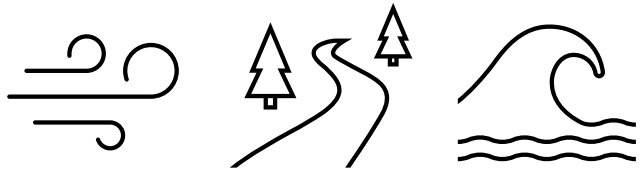
- Top MP contributer in Norway

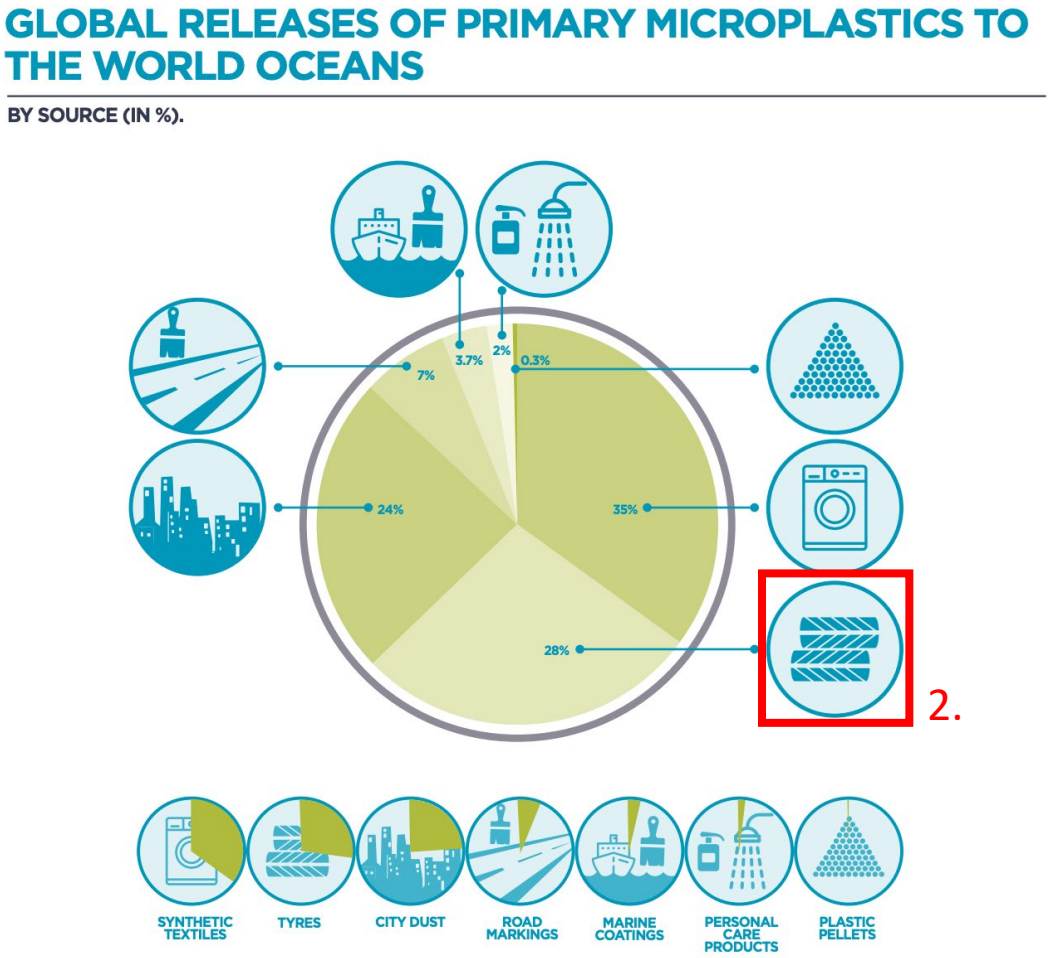


(European commission, 2023)

Transport to the environment

- Wind dispersion
- River transport
- Waste water
- Road runoff
- Snow dumping





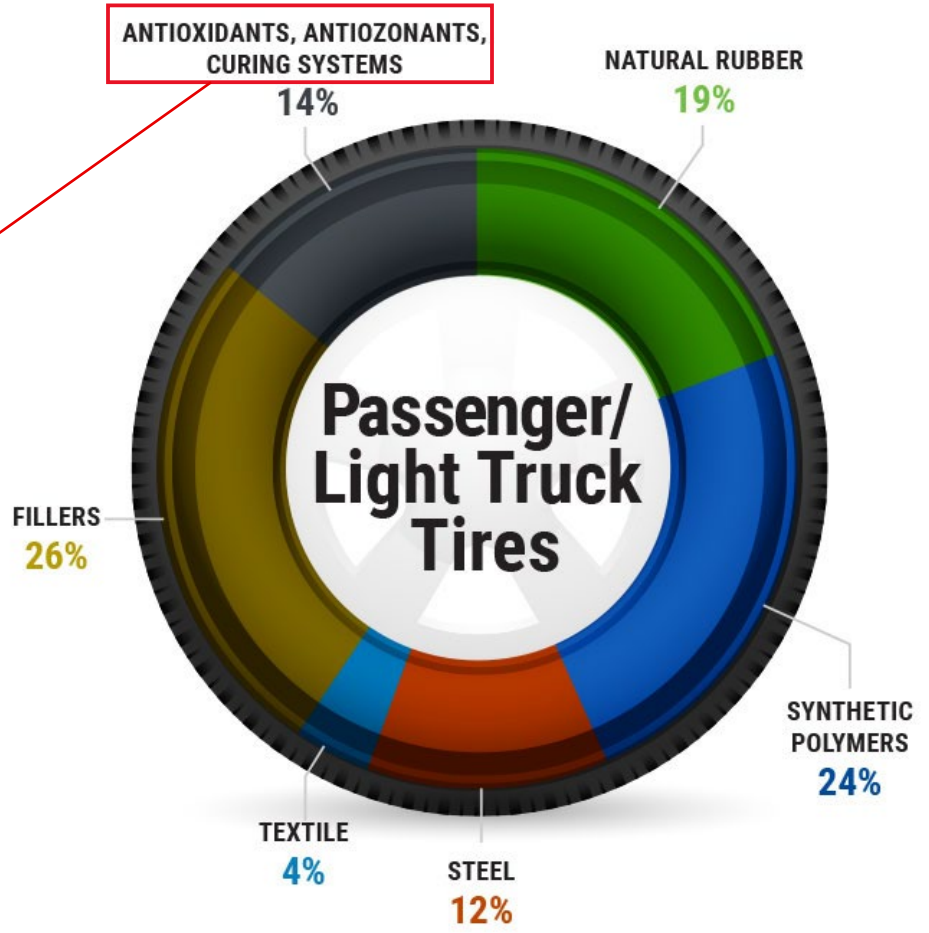
2.

(Boucher & Friot, 2017)

Car tire additives and toxicity

- Complex mixture of additives
- Heavy metals
  - Zn, Fe, Co… (Halsband et al., 2020)
- Contains over 200 organic chemicals (Müller et al., 2022)
  - Polyaromatic hydrocarbons (PAHs)
  - Phthalates
  - *p*-Phenylenediamines (PPDs)
    - 6PPD, CPPD, DPPD…

⇒ Leachable

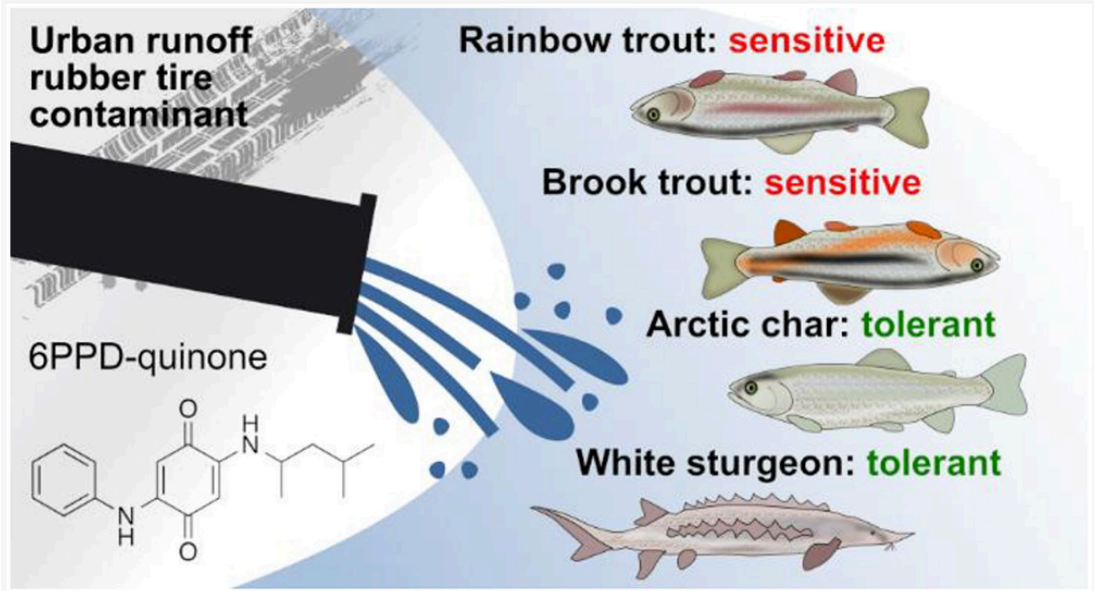


Modified from the U.S. Tire Manufacturers Association

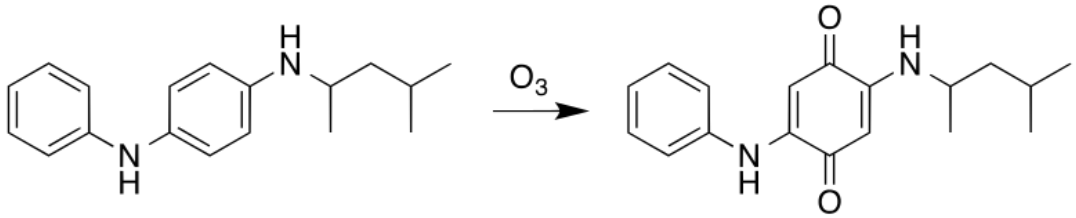
Car tire additives and toxicity

6PPD

- Antioxidant
- 0.4 – 2 % in a new car tire (Babbit, 2010)
- Transformation product: 6PPD-quinone
  - Linked to causing acute mortality in coho salmon (*Oncorhynchus kisutch*) (Tian et al., 2021)
  - High differences in species vulnerability



(Brinkmann et al., 2022)



6PPD 6PPD-quinone

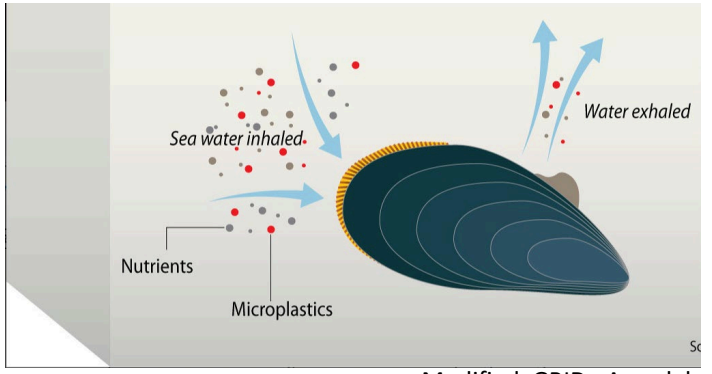
What do we know about CTRPs?

Large knowledge gaps!

- Challenges with **detection**
- **Distribution** of CTRPs to the marine environment
- **Uptake** of CTRPs in marine organisms
- **Absorption** and **accumulation** of CTRP-related-chemicals in marine organisms

The Blue mussel (*Mytilus edulis*)

- Selective filter feeder
- Easily collected
- Used in biomonitoring
  - Reflects surrounding environment
  - Ingest microplastics and related chemicals



Modified, GRID - Arendal

Research questions

- To what extent do blue mussels **absorb** and **accumulate** CTRP-related chemicals?

- Which specific chemicals among the ones considered can serve as **potential biomarkers in blue mussels** from recent exposure to CTRPs?

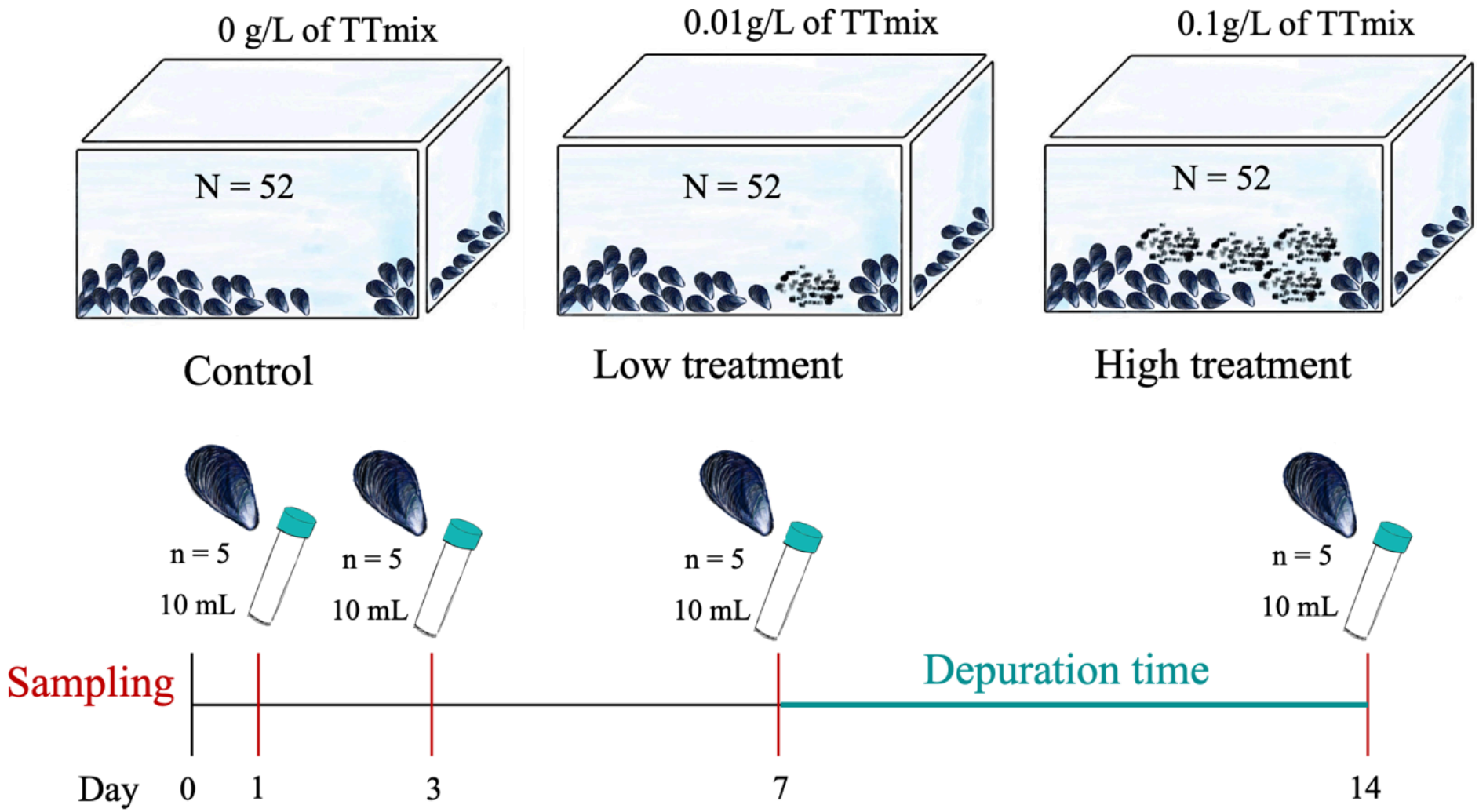
Methods

⇒ Controlled laboratory **exposure experiment**

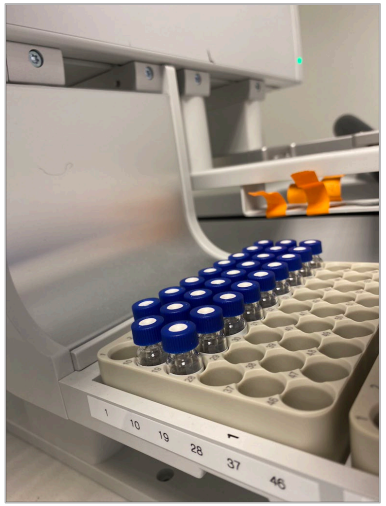
⇒ Investigate CTRP targeted related organic chemicals in blue mussel soft body tissue

- ⇒ 6PPD and 6PPD-Q

Blue mussel exposure experiment



Extraction and anic chemicals



Homogenization

N = 60

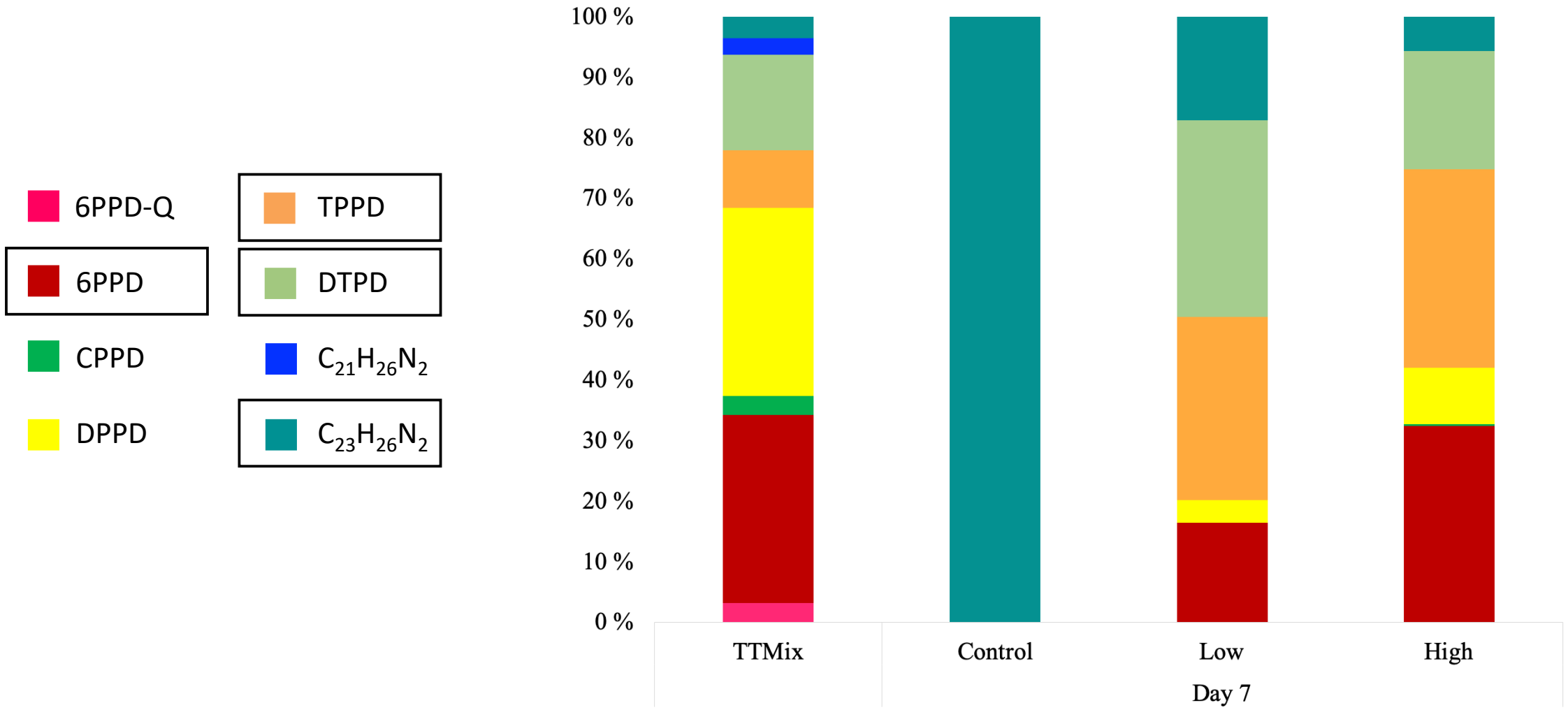
N = 12

Ext

Analysis
chromatography mass spectroscopy)

6PPD-Q
6PPD
CPPD
DPPD
TPPD
DTPD
$C_{21}H_{26}N_2$
$C_{23}H_{26}N_2$

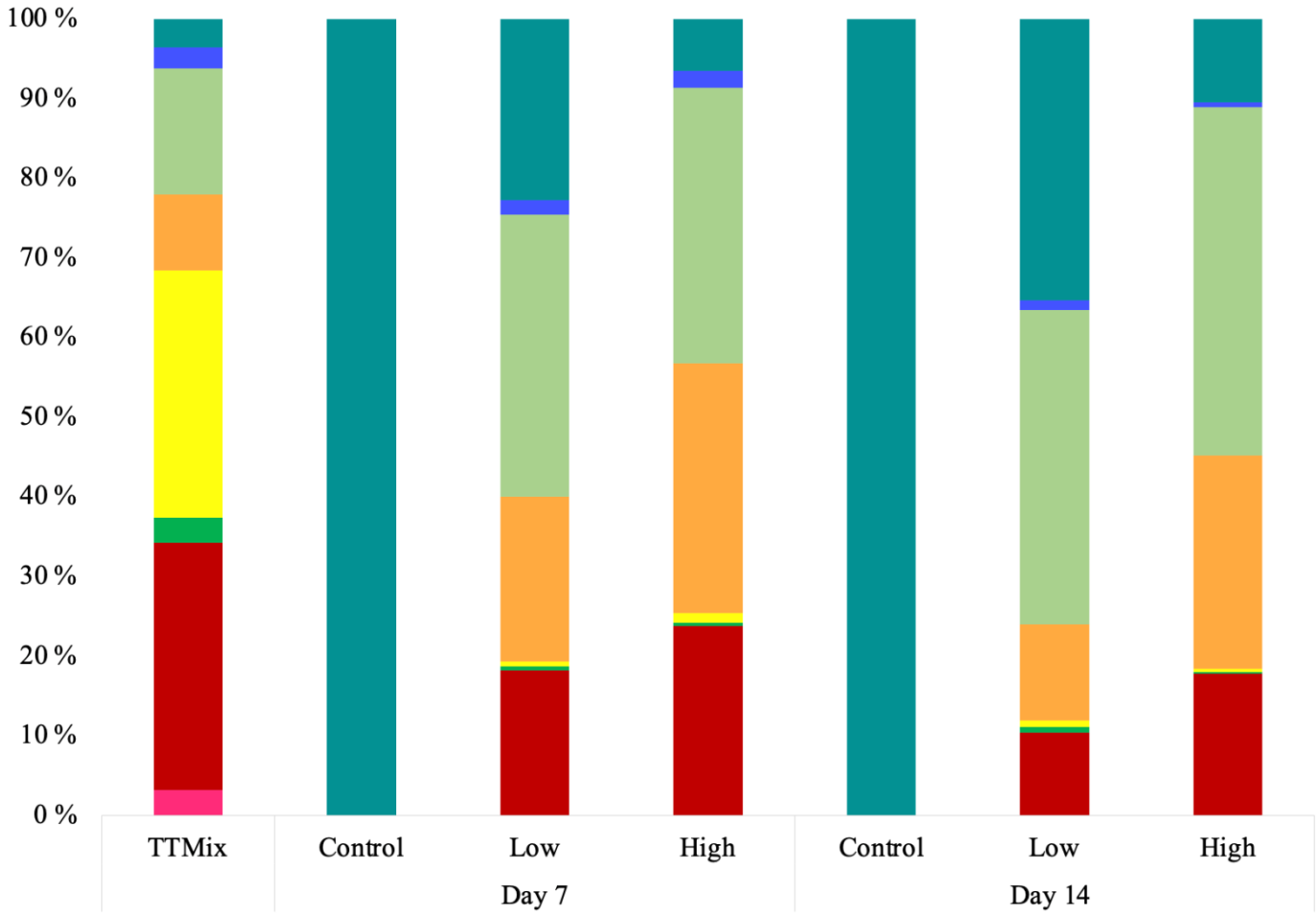
CTR-related chemicals detected in tank water



CTR-related chemicals detected in whole body mussels

⇒ No detection of 6PPD-Quinone

6PPD-Q
TPPD
6PPD
DTPD
CPPD
$C_{21}H_{26}N_2$
DPPD
$C_{23}H_{26}N_2$

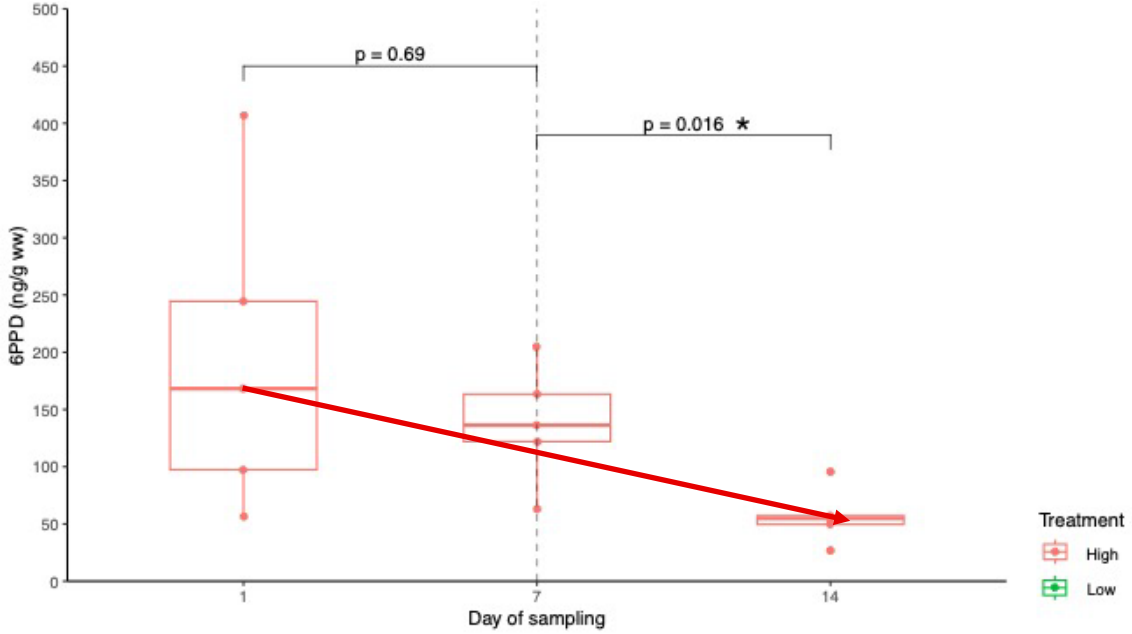


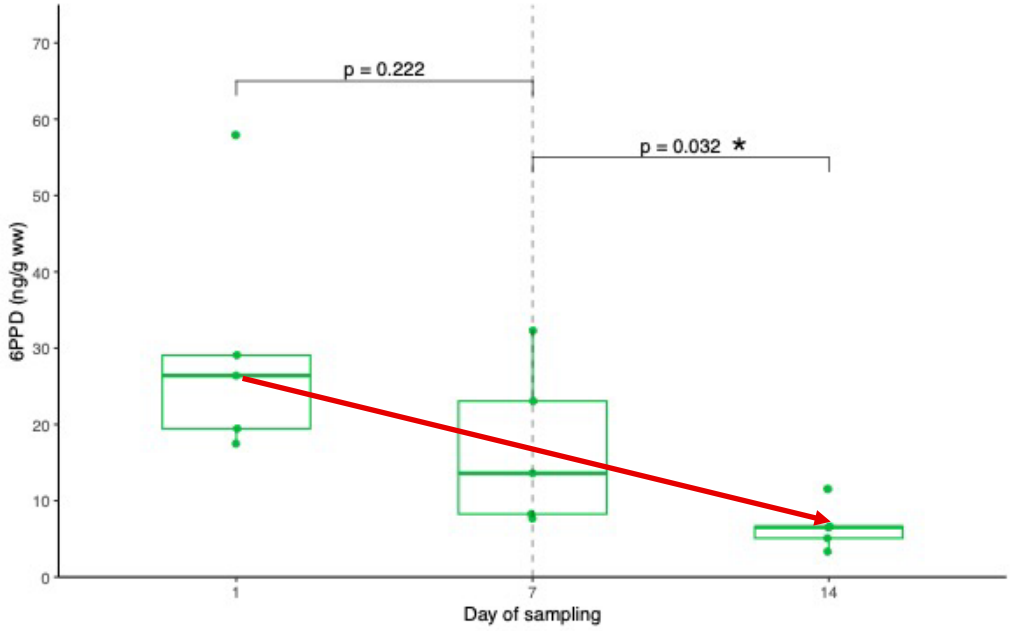
6PPD in body mussels

⇒ No accumulation during exposure

⇒ Detectable after 7 days of exposure

⇒ Relationship between uptake and treatment





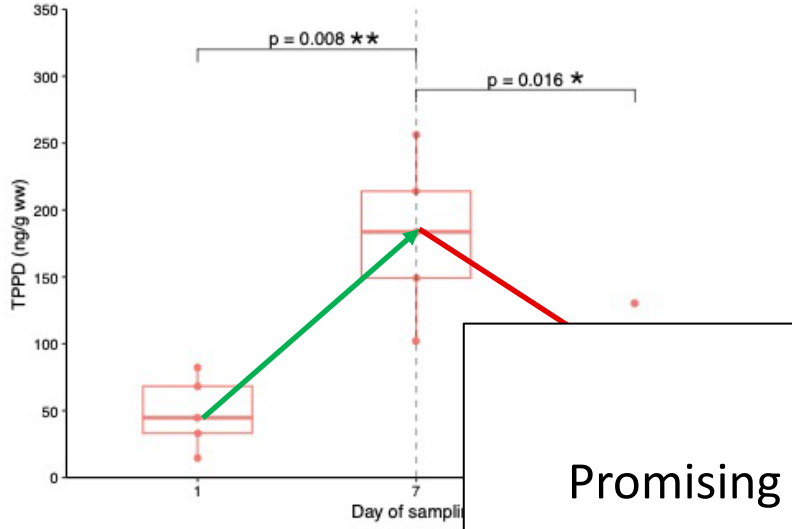
Exposure

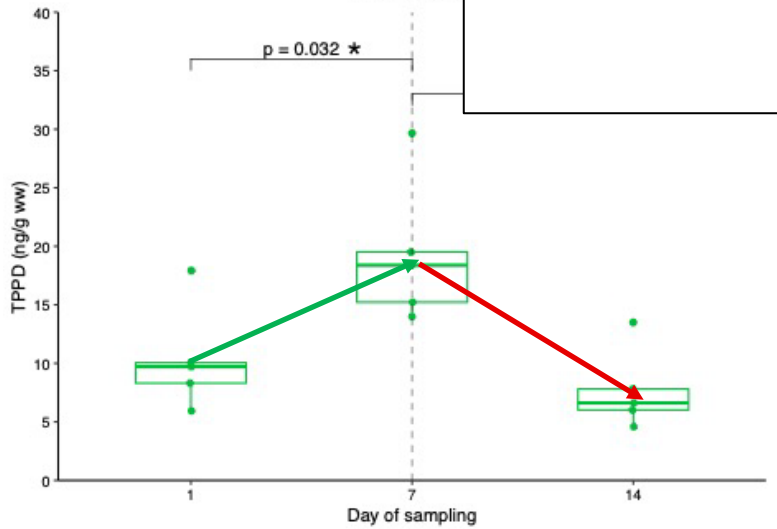
Depuration

TPPD

⇒ Accumulation during exposure

⇒ Concentrations decreased significantly

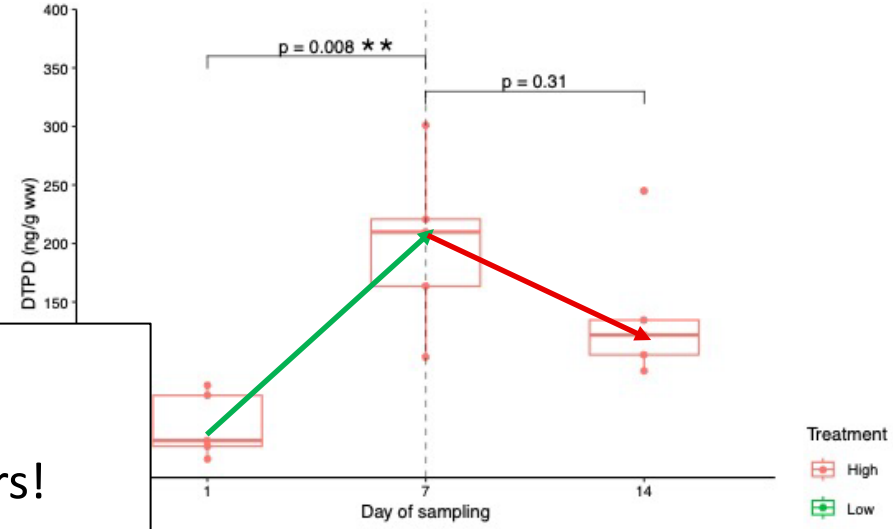


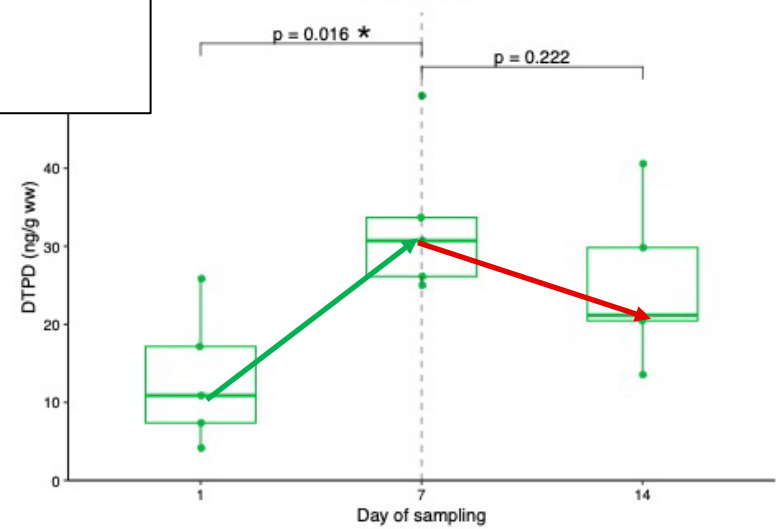


DTPD

⇒ Accumulation during exposure

⇒ Concentrations did NOT decrease significantly





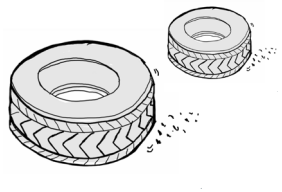
Promising candidate markers!

Main findings

⇒ Blue mussels **ingest** car tire rubber and **take up** related chemicals in relation to exposure

⇒ Blue mussels **do not accumulate 6PPD**, but the chemical can **remain** within the mussels for at least 7 days after exposure

⇒ Blue mussels **accumulate TPPD** and **DTPD** during exposure and the chemicals **remain** within the mussels for at least 7 days after exposure



Conclusion

$\Rightarrow$ PPDs – 6PPD, TPPD and **DTPD** can serve as potential **biomarkers** in blue mussel soft body tissue after recent exposure to CTRPs

Acknowledgements

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Findings in wild mussels

⇒ 6PPD detected in test mussels